the selected intervals form a set of potency *c*. Similar theorems apply to areas and volumes: thus, if we take a unit square it is possible to "black out" a definite region within it, the area of which may be less than any *given* quantity, in such a way that no circle, however small, can be placed within the square without covering some at least of the black region, and so that the points not within the black region form a set of potĕncy *c*. It should be specially noticed that although the black region is, or may most conveniently be, constructed by an infinite process, it is perfectly definite, in the sense that we can say whether any given point (x, y) lies within it or not.

Another point to which attention may be called is the definition of "curve" (p. 219) as a set of points having certain properties. This is quite distinct from the idea of a path traced by a continuously moving point, and leads to very curious and interesting problems relating to rectification and quadrature.

Enough has been said to show how interesting and novel are the contents of this treatise; the examples and figures are of great help in making the general arguments intelligible, and the bibliography will enable the reader to consult all the literature relating to the subject. Finally, the appendix should not be overlooked, as it contains some important additional matter, besides a few corrections. To the latter may be added "chap iv., § 20," instead of "chap. iv., § 3," on p. 77.

G. B. M.

METAMORPHOSES OF PLANTS.

Jugendform und Blütenreife im Pflanzenreich. By Dr. L. Diels. Pp. 130; with 30 illustrations in text, each with several figures. (Berlin: Gebrüder Borntraeger, 1906.) Price 3.80 marks.

IN this work the author has presented much interesting information from the point of view of an inquiry into the relations between sexual maturity and the conditions attained by the vegetative organs, especially where these from any cause show tendencies to marked changes of aspect during the development of the plants. Many of his examples are drawn from his personal investigations, the inquiry having suggested itself to him during a residence in Western Australia, where peculiarities in these relations appear to be remarkably frequent, and to be often traceable to the environment. He has also made a careful study of such published works as bear on this subject, and has used the materials derived from them with good effect as regards both the facts and the causes of abnormal conditions, and the inferences to be drawn from them. His statement of the whole subject, and of the conclusions that he believes can be fairly based on what is yet known of it, is well and clearly put, and shows the need of further inquiry, as well as the risk of pressing inferences beyond their fair limits at times.

The book is deserving of attentive perusal, and will suggest to the careful reader parallels among our own plants to some of the cases described, and questions in need of investigation from the new standpoint. The book opens with a discussion of the conditions that favour the attainment of sexual maturity in the normal course of development, and also prematurely, as measured by the stage of development of the vegetative organs. By selected examples it is shown how variable are the stages of progress, when judged by the leaves especially, at which sexual reproduction may occur. Attention is also directed to the assemblages of different species that exist on dry, poor soil, and that are distinguished by the production of precocious flowers and fruits on ill-nourished dwarfs, as well as to the production of flowers in cultivated seedlings of various trees, as in the *Swietenia Mahagoni*, recorded by Mr. Hemsley (Hooker's "Icon.," 2786), where deficiency of water appears to be the exciting cause.

The unusual precocity of reproduction is most evident where there is naturally a succession of leaf-forms before the normal period of flowering is reached, some of these being regarded as characteristic of the immature, and others of the adult plant. For the definite grades in such a succession Dr. Diels employs the term "Helikomorphie," the whole being included in the "Heteroblastie" of varied forms of parts having the same morphological value. The significance of the helicomorphies, where not of the grade usually associated with flowering, is shown to differ in different plants. In some even those characteristic of the normal immature plant may not be fully exhibited. In others these may be fully shown; but those of the adult may remain undeveloped or arrested. The causes that lead to such departures from the usual course can be shown to lie in the environment in some cases; but in others they cannot yet be explained. Among the more frequent causes of arrest and retention of immature characteristics are influences that interfere with growth, such as deficiency of water in dry soils, inclement weather at high elevations, shading and overcrowding, the plants grown under such conditions showing an unusual tendency to flower while having leaf-organs of the normal immature grade.

A comparison of allied species shows that the normal youthful helicomorphy of one may be very similar to the normal adult condition of another that lives in less favourable surroundings, *e.g.* in *Ranunculus sceleratus* and *R. pygmaeus*.

The importance of a thorough comprehension of these variations, of their significance in the life of each species, and of their value as indications of relationships between species or larger groups in classification, is self-evident. Embryology has not afforded like help in systematic botany to that obtained from it in zoology. In some cases seedling plants for a brief time show characters very unlike the adults, and suggestive of the structure of less modified allied forms, as in the well-known examples of Ulex and Acacia. All such deserve careful study; and Dr. Diels has shown how they throw light on the value of "species," as in the forms of Limosella, and of "genera," as in the relation of Regnellidium to Marsilia. His discussion of the relations of certain species of Hakea, of Grevillea, and of numerous others, largely on the basis of his personal observa-

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tions on the plants in their native habitats, is of great interest. The "larval" forms habitually passed through by certain plants, *e.g.*, by *Veronica epacridea*, Actinostrobus, sps., and other conifers, various Leguminosæ, Eucalyptus, sps., Aloineæ, and members of other groups, are also discussed; and the conditions under which sexual reproduction may occur in plants that retain their larval aspect are investigated. That such plants have been described and named as distinct from the usual adult forms is well known, and this is seen to have been the case in Eucalyptus and in other groups.

A chapter on the phylogenetic significance of helicomorphy sums up the conclusions of the author. Many of the forms he regards as adaptations to environment, some of which are unstable, while others show the influence of heredity and persist under new conditions, *e.g.* the formation of phyllodes by Acacias in greenhouses. Some appear to become relatively constant in a short time, *e.g.* seasonal dimorphism of *Euphrasia Rostkoviana* and *E. montana*, believed by Wettstein to have become fixed as the result of the alpine meadows being mowed, and now retained in cultivation in a botanic garden. But, while there may in some be a strong hereditary tendency to repetition of the cycle, Diels concludes that each helicomorphic stage may be the starting-point of a new phylogeny. He emphatically opposes the belief that the helicomorphy of the immature plant necessarily represents a condition similar to that of the ancestors; and asserts that the apparently ancestral form has in many cases been acquired in response to the environments of the young plant. *Acacia insolita* is quoted as an example of a species descended from phyllode-bearers that now habitually produces pinnate leaves abundantly when mature; and the position is briefly stated thus:—"We saw that Phylloglossum resembles the young of many species of Lycopodium. But Lycopodium does not for that reason follow Phylloglossum in phylogeny; Phylloglossum may just as well be younger than the greater number of the Lycopods." The assumption that the infantile form must in all circumstances represent an older stage of ancestry than does the adult is frequently in opposition to the facts. A brief review of similar phenomena in the animal world, and a short bibliography, conclude the book. It only remains to add that the illustrations are excellent, and that a good index makes reference easy to the stores of information.

THE RADIO-ACTIVE PEDIGREE.

Radio-active Transformations. By Prof. E. Rutherford, F.R.S. Pp. 287. (London: Constable and Co., Ltd., 1906.) Price 16*s.* net.

THIS work is, in the main, a reproduction of Prof. Rutherford's Silliman lectures, delivered at Yale in March, 1905, and represents his latest views on the subject. Some treatment of radioactivity in general is given, and then a detailed development of the special subject of the book. This treatment differs only from the author's previous expositions in the greater detail in which the subject is worked out. Every month seems now to bring to light some hitherto unrecognised stage in the transformation of one of the radio-elements. One would suppose, however, that this field of discovery cannot be of unlimited extent, and that the full detail of the transformations must, before long, be made out, so far at least as they are accompanied by demonstrable radio-activity.

It has been usually assumed that each radio-active atom throws off an α particle, and becomes thereby transformed into an atom of a new product. On this view, it can be seen, with a little thought, that a mineral in radio-active equilibrium ought to owe an equal proportion of its activity to each of the products of a series, and there is considerable evidence that it is often so. Lately, however, two cases have presented themselves which seem clearly inconsistent with this. One of them, that of actinium, is mentioned by Prof. Rutherford in the present work. It seems that actinium, like radium, is found in uranium minerals, and in those only. Further, that the amount of actinium is probably, as the amount of radium is certainly, proportional to the uranium content. If so, we cannot but conclude that actinium is a member of the uranium series. Now comes the difficulty. Actinium certainly does *not* contribute anything like so much to the total activity of pitchblende as radium and uranium each do.

The second case is to be found in a paper in the October *Philosophical Magazine.* Moore and Schlundt have found that uranium X, the immediate product of uranium, gives a small α radiation as well as the β radiation by which it is mainly characterised. It is certain, however, that the α radiation of uranium is not much diminished by removing all the uranium X from it, hence the α radiation of uranium X must be comparatively small. Here again the principle of equal activity in each successive product of a series is violated. This latter case has only been brought to light since the publication of the present work, and quite a new light has been shed on the case of actinium by Dr. Boltwood's letter to NATURE describing the formation of radium from actinium. This seems to make it certain that actinium is in the main line of radio-active descent, and to put out of court Rutherford's plausible suggestion that it is the head of a collateral family. The subject, indeed, progresses so fast that the reviewer of a book like this almost always has lights which were not available to the author at the time of going to press.

The subject of the possible ultimate production of lead by the radium series is here discussed in some detail. It is doubtful, I think, whether much stress should be laid on the almost invariable presence of lead in uranium-radium minerals. An interesting spectroscopic investigation by Hartley and Ramage (*Engineering*, September 24, 1897) proved that lead was present in almost every one of a very large collection of iron ores examined by them. We cannot suspect a change akin to radio-activity in this case, for lead has a much larger atomic weight than iron,

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